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Impact of Temperature and Solar Radiation on Photovoltaic Cell Efficiency: A Simulation Study Using MATLAB

Almotaz bellah M. Abouda[1*], Osama Ali Badi[2], Saad H. Salem[3], Mohammed I. Altwati[4]
1,3,4 Department of Electromechanical Engineering, College of Industrial Technology, Misurata, Libya,
2, Department of industrial & Manufacturing Eng., Engineering College, Misurata university, Misurata, Libya
✉ a.abouda@cit.edu.ly, saad_hafed@cit.edu.ly, mohammed_eltowati@cit.edu.ly, osama.badi@eng.misuratau.edu.ly

Abstract**—** This research targets studying the impact of temperature and solar radiation on two types of photovoltaic cells: monocrystalline and polycrystalline. This paper examines, through the use of MATLAB simulation, the variation in these environmental factors for significant parameters such as efficiency, power output, and voltage characteristics in order to deduce the superior performance type under high-temperature conditions. This was simulated for temperature and solar radiation variations from 25°C to 65°C, in 10°C steps, and 200 W/m² to 1000 W/m², in 200 W/m² steps, respectively. For both types of cells, constants, variables, and specifications were programmed into MATLAB, while iterative loops calculated the behavior of the cells under these conditions. Results have been presented as performance curves and graphs that relate temperature and solar radiation with the performance of photovoltaic cells. From the results, it can be obtained that monocrystalline cells are more efficient in the test conditions described because of their being less affected by temperature rises compared to the polycrystalline ones. The investigation clearly shows how the choice of different photovoltaic technologies must take into consideration meteorological factors, especially for zones with high temperatures or variable radiation.

Index Terms — PV, polycrystalline, monorystalline, temperature, radiation.

I. INTRODUCTION

With the world increasingly shifting to renewable sources of energy, solar energy is at the forefront, promising a clean, sustainable, and abundant alternative to fossil fuels. Solar energy is recognized to be highly effective in reducing greenhouse gas emissions, therefore fitting into the global effort to combat climate change and attain energy sustainability [1]. Among the technologies for harnessing solar energy, the photovoltaic systems are one of the most reliable and scalable methods to convert sunlight directly into electrical energy. In Libya, rooftop PV systems have been studied as a promising solution to mitigate the ongoing power shortage challenges, as demonstrated in[2]. The performance and efficiency of PV cells depend a lot on the surrounding atmosphere, having temperature and solar radiation as the most relevant factors [3]. The photovoltaic cells are generating electricity powered by the energy of sunlight, so the performance of these kinds of cells is closely related with the intensity of solar radiation. Greater solar radiation means more energy input into the cell, but simultaneously it heats up the temperature and reduces the cell's efficiency [4]. This is due to the fact that high temperatures occasion increased thermal losses and decreased open circuit voltage. Inevitably, all this leads to very low total energy output from photovoltaic elements. The discussion above also challenges the complete and thorough understanding of various responses among photovoltaic technologies due to environmental condition alterations. In these respects, attaining greater proficiency in both the design and application of such solar photovoltaic systems will play a decisive factor, particularly concerning harsh climatic conditions.

Various studies are conducted to observe the effect of temperature and solar radiation on photovoltaic performance, which presented valuable information with respect to environmental conditions. To illustrate this statement, Jihad Adeeb et al [5]. (2019) presented simulation-based analysis concerning various photovoltaic technologies considering the temperature effects on their operation. Their test results illustrated that, under different test conditions, monocrystalline cells yielded higher efficiencies and were less temperature-sensitive than any other technologies. This work pinpoints the need to implement some thermal management strategy in order to reduce losses in efficiency and improve the operational reliability of a photovoltaic system.

Similarly, A.D. Das et al [6]. (2014) presented the research influence of thermal stress on the performances of the Photovoltaic cell and modules in both simulation and experimental studies. Their work analyzed that due to high temperature the power output along with the photovoltaic efficiency is tremendously affected. They had suggested some cooling mechanisms along with advanced materials, which are highly effective for handling thermal properties as a future means of minimizing such thermal losses. The study further emphasized the importance of accurate simulation models

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in order to predict realistic conditions for photovoltaic cell performance, providing a very vital basis necessary in optimizing the design of photovoltaic systems. Abdulrahman T. Mohammed and Wissam A. M. Al-Shawhani [7], in the year 2022, extended the previous studies by using numerical and experimental methods in investigating the impact of temperature fluctuation on the performance of PV modules. The results indicated a high reduction in power output with fluctuations in temperature, therefore highlighting the need for design improvements to ensure that photovoltaic modules are more thermally stable. Although their work has provided valuable insight into the thermodynamics of photo-voltaic systems, this work was primarily dedicated to the study of individual modules rather than the performance comparison of various PV technologies under a unified simulation framework.

Despite advances in research determining the effect of temperature and solar radiation on photo voltaic cells, there remains a definite dearth in proper research in the subject area. Most studies up to now consider either a comparative analysis of different simulation-experiment results related to the same PV cell type or an analysis concerning the performance of single PV modules. Only limited research directly compared the performance under consistent simulation conditions of monocrystalline and polycrystalline cells. This will address an important knowledge gap in the field and comprehensively understand the various relative advantages and limitations of these widely used PV technologies.

This paper, therefore, tries to fill this gap by carrying out a comparative analysis of monocrystalline and polycrystalline PV cells through MATLAB simulation. the study simulates the impact of temperature and solar radiation on these two kinds of cells to ascertain which technology is more superior in terms of performance and stability when environmental conditions change therefore, this study aims to quantitatively assess and compare the performance degradation patterns of monocrystalline and polycrystalline photovoltaic cells under varying temperature and solar irradiance levels using MATLAB simulations. The objective is to determine which cell type is more resilient to high-temperature stress in order to inform PV system design in hot climate regions.

II. RESEARCH HYPOTHESES

In light of the study objectives and the identified knowledge gap, the following hypotheses were formulated to guide the simulation and analysis process:

1. The efficiency of photovoltaic cells decreases with increasing temperature due to the reduction in open-circuit voltage.
2. Higher solar irradiance levels lead to increased power output and efficiency, mainly through the enhancement of short-circuit current.
3. A MATLAB-based simulation model can effectively predict the influence of environmental factors (temperature and irradiance) on the performance of different photovoltaic cell technologies.

III. METHODOLOGY

To investigate the impact of temperature and solar radiation on the performance of monocrystalline and polycrystalline photovoltaic (PV) cells, a simulation-based approach was employed. The study used MATLAB software to model the behavior of both PV cell types under varying environmental conditions.

In this simulation-based experimental design, the independent variables are:

- Solar cell temperature (ranging from 25°C to 65°C, in 10°C steps)
- Solar irradiance (ranging from 200 W/m² to 1000 W/m², in 200 W/m² steps)

The dependent variables that were observed and analyzed in this study include:

- Maximum power output
- Open-circuit voltage (Voc)
- Short-circuit current (Isc)
- Fill Factor (FF)
- Overall cell efficiency

These variables were calculated for both monocrystalline and polycrystalline PV cells under all simulation scenarios to enable a comparative assessment of their performance under varying environmental conditions.

The methodology is structured into the following key steps:

1. Data collection and parameter selection: The parameters for monocrystalline and polycrystalline photovoltaic cells were obtained from a dataset provided by a specific manufacturer. The dataset included the key performance metrics and technical specifications for each cell type, as shown in Table 1.

Table 1: Study Model Specifications

Photovoltaic cell parameters	Monocrystalline	Polycrystalline
Photovoltaic panel Power	625W	625W
Photovoltaic panel length	2465mm	2465mm
Photovoltaic panel width	1134mm	1134mm
Open-circuit voltage	56.18V	52.27V
Short-circuit current	13.13A	14.30A
maximum power voltage	47.61V	43.17V
maximum power current	13.13A	14.3A
Solar radiation intensity at reference conditions	1000W/m^2	1000W/m^2
Solar cell Temperature at reference conditions	298.15K	298.15K
ampient Temperature at reference conditions	298.15K	298.15K
Efficiency at reference conditions	22.4%	22.4%

These parameters served as inputs to the simulation model and were used to accurately represent the characteristics of each PV cell type under varying environmental conditions.

2. Mathematical Modeling: The performance of PV cells was modeled using standard equations that describe their electrical behavior. Key equations used in the study included:

Photovoltaic Cell Power:

The Power of a photovoltaic cell measures the efficiency with which light energy is converted into electrical energy, expressed in watts, under specified solar radiation conditions. It is affected by various factors, including cell efficiency, which is the ratio of electrical energy produced to the energy of the incident light, cell area, which determines the amount of light absorbed, and temperature, as higher temperatures result in lower efficiency. Photovoltaic cell Power is typically calculated using a standard equation that incorporates these factors to evaluate cell performance under different environmental conditions, as shown in equations (1,2) [8].

$$P_{max} = V_{oc} * I_{sc} * FF \qquad (1)$$

$$\mathrm{P} = N_s * N_p * \mathrm{V} * \mathrm{I} \qquad (2)$$

Where: P_{max} is The maximum power generated by a photovoltaic cell, measured in watts W, V_{oc} is the open-circuit voltage in volts V, $I_{sc}$is the short-circuit current in amperes A. FF is the fill factor, P The electrical power produced, N_s the number of series cells, N_p number of parallel cells, V, I the voltage and current produced.

Open circuit voltage V_{oc}:

It is the voltage at which no current flows in the external circuit, it is the maximum voltage that a solar cell can deliver, V_{oc} depends on the current density produced by the light and can be calculated from equation (3) assuming the net current is zero [8].

$$V_{oc} = \frac{K_B T}{q} \ln\left(\frac{j_{ph}}{j_0} + 1\right) \qquad (3)$$

The voltage of a single cell can be calculated from the following equation [7]:

$$V = -I * R_s + K * \log\left(\frac{I_{ph} - I + I_o}{I_o}\right) \qquad (4)$$

If the cells are in series connection, the voltage can be calculated from the following equation [7]:

$$V_{mo} = -I_{mo} * N_s * R_s + N_s * K * \log\left(\frac{I_{ph} - I + I_o}{I_0}\right) \quad (5)$$

If the cells are in parallel connection, the voltage can be calculated from the following equation [7]:

$$V_{mo} = -\frac{I_{mo} * R_s}{N_p} + K * \log\left(\frac{N_s * I_{ph} - I_{mo} + N_p I_o}{N_p * I_o}\right) (6)$$

Where: V_{mo} is the module voltage, I_{mo} is the module current, K is the Boltzmann's constant ($1.380649*10^{-23}$ j/k), T is the absolute temperature measured in Kelvin (K), q is the electron charge ($1.6*10^{-19}$ C), j_{ph} is The photocurrent density measured in amperes per square centimeter (A/cm^2), j_0 is the dark current density also measured in amperes per square centimeter (A/cm^2),

Short circuit current I_{sc}:

The Short circuit current is a current that passes through the external circuit when the electrodes of the solar cell are shorted, The maximum current that a solar cell can deliver depends largely on the optical properties of the solar cell, such as light absorption in the absorber layer and reflection. Equation (7) calculates the junction resistance of the solar cell (reverse current I_{RS}) based on the short-circuit current and temperature [8] [9].

$$I_{Rs} = \frac{I_{sc}}{e^{\left(\frac{q*I_{sc}}{n*K*T}\right)} - 1} \qquad (7)$$

Where: n is the Ideality factor of the diode.

The following equation determines the saturation current of the diode I_0, based on the reverse current.

$$I_0 = I_{RS} * \left(\frac{T_c}{T_{ref}}\right)^3 * e^{\frac{q*E_g}{n*k}*\left(\frac{1}{T_{ref}} - \frac{1}{T_c}\right)} \qquad (8)$$

Where: : T_c is the cell temperature, T_{ref} is the reference temperature, E_g is the energy gap.

Equation (9) expresses the generated photocurrent I_{ph} as a function of temperature, solar radiation, and short-circuit current.

$$I_{ph} = \frac{S}{S_{ref}} (I_{sc} + \alpha(T_c - T_{ref}) \qquad (9)$$

Where: S is the instantaneous solar radiation, S_{ref} is the reference solar radiation, α is the temperature coefficient of short-circuit current.

Equation (10) shows how to calculate the electric current of the solar cell I.

$$I = I_{ph} - I_0 \left(e^{\frac{qV}{nKT}} - 1\right) \qquad (10)$$

The following equation represents the relationship between the output current and the photocurrent with the reverse current [8].

$$I = I_{ph} - I_0 \left(e^{\frac{q(V*I*R_S)}{n*k}} - 1\right) \qquad (11)$$

Where: R_S is the series resistance.

Finally, equation (12) is a modified formula for the resulting current that takes into account the effects associated with internal resistance.

$$I = I_{ph} - I_0 \left(e^{\frac{q(V*I*R_S)}{n*k}} - 1\right) - \frac{V + I * R_s}{R_{sh}} \qquad (12)$$

This equation shows the circuit model of a solar cell with the inclusion of series and parallel resistance.

Where: R_{sh} is the parallel resistance.

Fill Factor:

The Fill Factor is a measure of the efficiency of a solar cell, which can be represented as the ratio of the effective power available from the cell (which is represented by multiplying the maximum power current I_{mp} by the maximum power voltage V_{mp}) to its maximum theoretical output (which is represented by multiplying the open-circuit voltage V_{oc} by the short-circuit current

I_{sc}) as it shown in equation (13). The optimum value of the Fill Factor is 1 [10].

$$FF = \frac{I_{mp} * V_{mp}}{V_{oc} * I_{sc}} \qquad (13)$$

The efficiency:

The efficiency of a photovoltaic cell is a measure of its ability to convert sunlight into usable electrical energy, where it is symbolized by η as It is calculated from the following equation [8] [9].:

$$\eta = \frac{V_{oc} * I_{sc} * FF}{S\ A} \qquad (14)$$

Calculating the temperature coefficient of photovoltaic cells:

Temperature greatly affects the performance of solar cells, as the thermal cell coefficients, short-circuit current coefficient α, open-circuit voltage coefficient β, and fill factor coefficient δ change with temperature.

The temperature coefficients of solar cells can be calculated using the following equations [6]:

$$\alpha = \frac{I_{sc(Tc)} - I_{sc(Tref)}}{T_c - T_{ref}} \qquad (15)$$

$$\beta = \frac{V_{oc(Tc)} - V_{oc(Tref)}}{T_c - T_{ref}} \qquad (16)$$

$$\delta = \frac{1}{FF}\frac{dFF}{dt} \qquad (17)$$

$$\gamma = \alpha + \beta + \delta \qquad (18)$$

3. Simulation Setup in MATLAB: This section focuses on simulating the effects of temperature and solar radiation on the performance of two types of photovoltaic cells: Monocrystalline Solar Cell and Polycrystalline Solar Cell. The study analyzes how performance parameters of these cells, such as efficiency and power output, are influenced by variations in temperature and solar radiation, aiming to determine which cell type is less affected under these changing conditions.

To achieve the desired results, a MATLAB script was developed. The code begins by defining constants, variables, and the specifications of the PV cells. Two nested loops were implemented to calculate the cells' performance under varying conditions. The temperature range was set from 25°C to 65°C, increasing in increments of 10°C, while the solar radiation was varied from 200 W/m² to 1000 W/m², increasing in steps of 200 W/m². The simulation produced various plots and curves that illustrate the impact of temperature and solar radiation on the performance parameters of both cell types, providing insights into their behavior under these environmental changes.

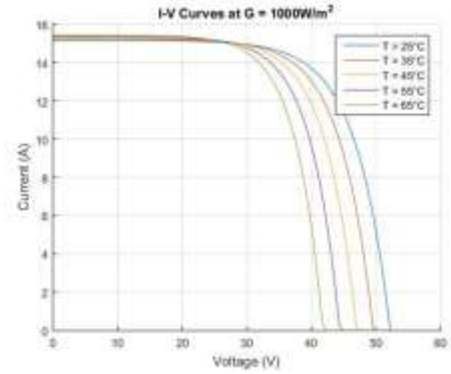
IV. RESULTS AND DISCUSSION

1. Current and voltage curve I-V:

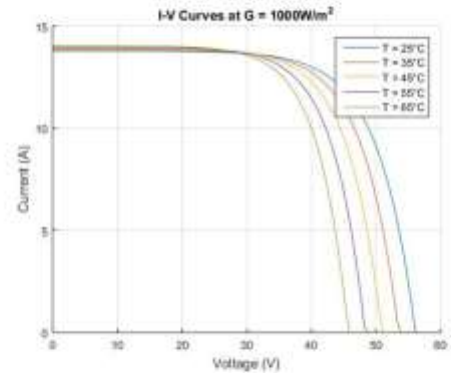
Solar cell Temperature affect:

The I-V curves for both monocrystalline and polycrystalline panels under a constant solar irradiance of 1000 W/m² in figure (1) reveal key performance trends across a temperature range of 25°C to 65°C. For both panels, the short-circuit current I_{sc} remains nearly constant, with monocrystalline panels showing an average I_{sc} of 13.79A and polycrystalline panels at 15.16A. However, the open-circuit voltage V_{oc} decreases significantly as temperature rises. In monocrystalline panels, V_{oc} drops from 56.18V at 25°C to 45.8 V at 65°C, representing a decline of 18.47%. Similarly, in polycrystalline panels, V_{oc} decreases from 52.27V to 42.18V over the same temperature range, marking a slightly higher decline of 19.3%.

This reduction in V_{oc} with increasing temperature directly impacts the maximum power point (MPP), with both panels experiencing a shift toward lower voltage and current values. While monocrystalline panels maintain slightly higher voltage levels at lower temperature.



Monocrystaline PV module



Polycrystaline PV module

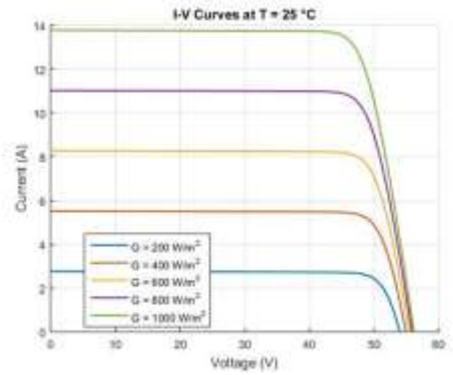
Figure 1. I-V curve of PV module at 1000 W/m²

Solar radiation intensity affect:

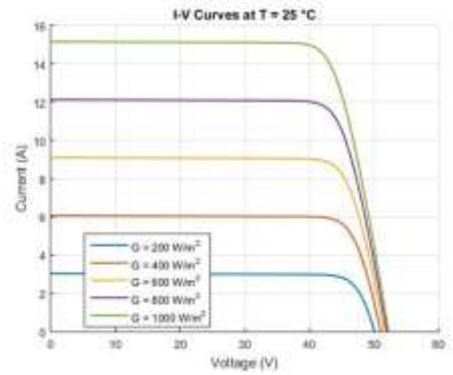
The I-V curves shown in figure (2) for both monocrystalline and polycrystalline panels at a constant temperature of 25°C and varying solar irradiance levels (200W/m² to 1000W/m²) exhibit consistent trends. For both panel types, each solar irradiance level corresponds to a distinct I-V curve. The open-circuit voltage V_{oc} remains relatively stable across all irradiance levels, ranging from 56.18V to 53.8V for monocrystalline panels and from 52.27V to 50 V for polycrystalline panels. This indicates minimal variation in voltage due to changes in irradiance.

In contrast, the short-circuit current I_{sc} increases significantly with rising solar irradiance, highlighting the direct proportionality between current and irradiance. For monocrystalline panels, I_{sc} rises from approximately 2.8A at 200 W/m² to 13.79A at 1000 W/m², while for polycrystalline panels, I_{sc} increases from about 3.2A to

15.16A over the same irradiance range. These substantial increases in I_{sc} demonstrate the strong dependence of current generation on the amount of incident sunlight.
Furthermore, the linear portion of the I-V curve extends as irradiance increases, indicating a significant rise in the maximum power that can be generated.



Monocrystaline PV module



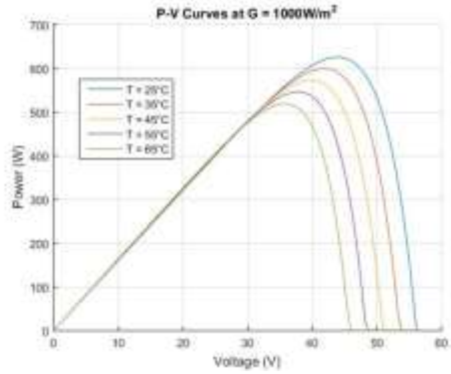
Polycrystaline PV module

Figure 2. I-V curve of PV module at 298.15K

2. Power and voltage curve P-V:

Solar cell Temperature affect:

The P-V curves shown in figure (3) for both monocrystalline and polycrystalline panels at a constant solar irradiance of 1000 W/m² demonstrate significant variations in power output as the temperature changes from 25°C to 65°C. For both panel types, the maximum power P_{max} decreases with rising temperatures, illustrating the thermal sensitivity of photovoltaic panels.
For the monocrystalline panel, P_{max} starts at approximately 625 W at 25°C and gradually decreases to around 520 W at 65°C, marking a decline of 16.8%. Similarly, for the polycrystalline panel, P_{max} drops from 625W at 25°C to 510W at 65°C, reflecting a slightly larger reduction of 18.4%. These declines highlight the impact of elevated temperatures on the energy conversion efficiency of both panel types.
The voltage at the maximum power point V_{mp} also decreases with temperature. For monocrystalline panels, V_{mp} ranges from 56.18V at 25°C to 45.8V at 65°C, whereas for polycrystalline panels, V_{mp} ranges from 52.27V to 42.18V over the same temperature range. This reduction in voltage, combined with a relatively stable current output, accounts for the observed decrease in power output.



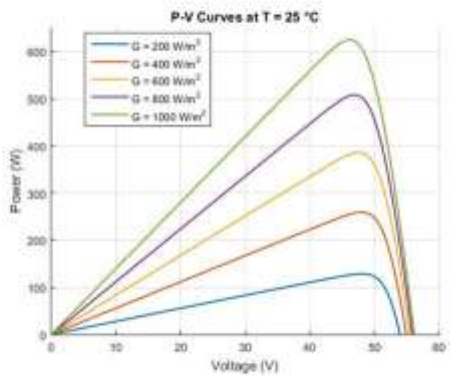
Monocrystaline PV module

Polycrystaline PV module

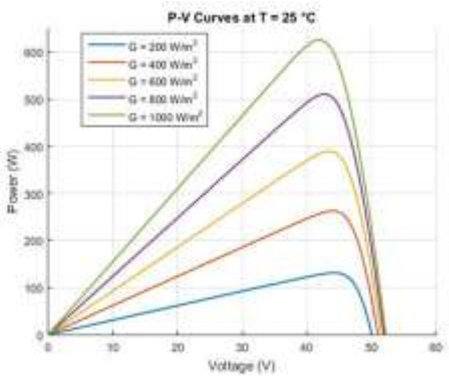
Figure 3. P-V curve of PV module at 1000 W/m^2

Solar radiation intensity affect:

Figure (4) show the P-V curves for monocrystalline and polycrystalline panels, respectively, at a constant temperature of 25°C and irradiance levels ranging from 200W/m² to 1000W/m². The maximum power P_{max} increases significantly with irradiance for both panel types. In the monocrystalline panel, P_{max} rises from approximately 120W at 200W/m² to 625W at 1000W/m², representing an 80.8% increase. Similarly, the polycrystalline panel shows an increase in P_{max} from 135W to 625W, a rise of 78.4%.
In both panels, the open-circuit voltage V_{oc} remains relatively stable, while the short-circuit current and maximum power output increase proportionally with irradiance.



Monocrystaline PV module

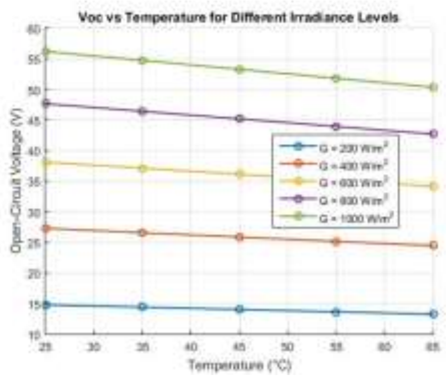


Polycrystaline PV module

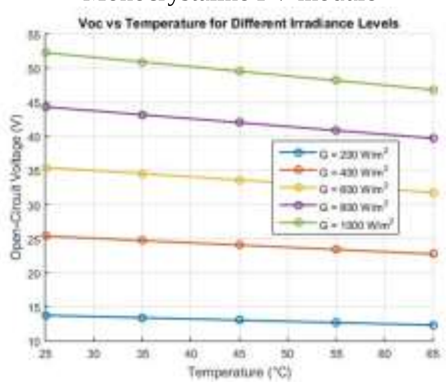
Figure 4. P-V curve of PV module at 298.15K

3. Open circuit voltage curve with Solar cell temperature:

Figure (5) show the linear decrease in open circuit voltage V_{oc} with increasing temperature for both monocrystalline and polycrystalline panels under solar irradiance levels from 200W/m² to 1000W/m². At 25°C, V_{oc} increases with irradiance, ranging from 15V to 56.18V for monocrystalline panels and from 14.2V to 52.27V for polycrystalline panels. At 65°C, V_{oc} decreases to 13.5V and 51V (monocrystalline) and 12.3V and 42.18V (polycrystalline)



Monocrystaline PV module



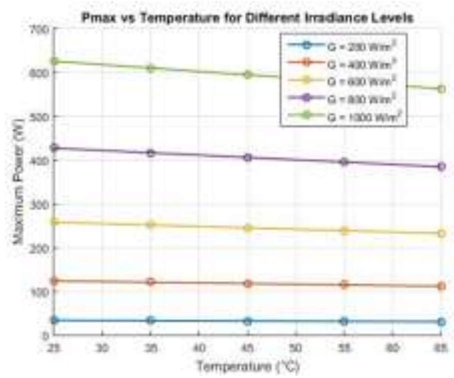
Polycrystaline PV module

Figure 5. Open circuit voltage curve with Solar cell temperature

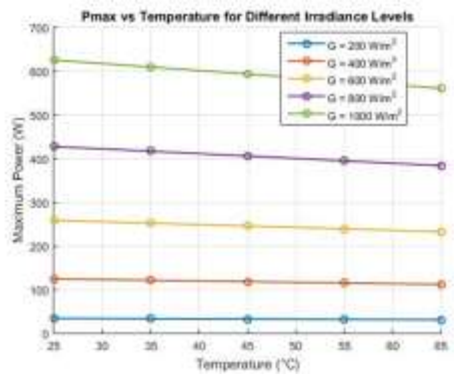
4. Power output curve with solar cell temperature:

The relationship between temperature and maximum power P_{max} in figure (6) shows a clear decline as temperature increases across all irradiance levels. At a constant irradiance of 1000W/m², P_{max} decreases from 625W at 25°C to approximately 570W at 65°C, representing an 8.8% reduction for Monocrystalline solar cell, while Polycrystalline Solar cell experiences a 10.4% drop to 560W. This reduction results from the temperature-induced decrease in open-circuit voltage V_{oc}, which shifts the maximum power point (MPP) toward lower voltage values.

Conversely, P_{max} increases significantly with higher irradiance. At 25°C, the power rises from 40W at 200W/m² to 625W at 1000W/m², marking a 93.6% increase for Monocrystalline. At 65°C, a similar trend is observed, with power decreasing from 40W to 35W at 200W/m² and from 625W to 575W at 1000W/m². Another panel "Polycrystalline solar cell" exhibits comparable behavior, where P_{max} drops from 37W to 33W at 200W/m² and from 625W to 570W at 1000W/m² as temperature increases.



Monocrystaline PV module

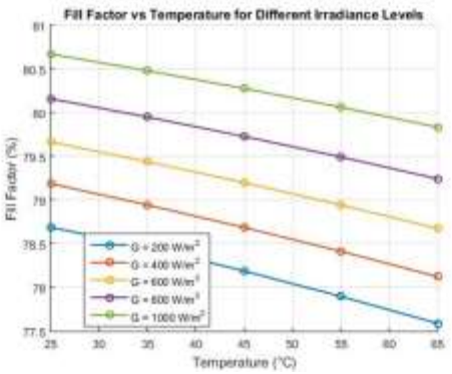


Polycrystaline PV module

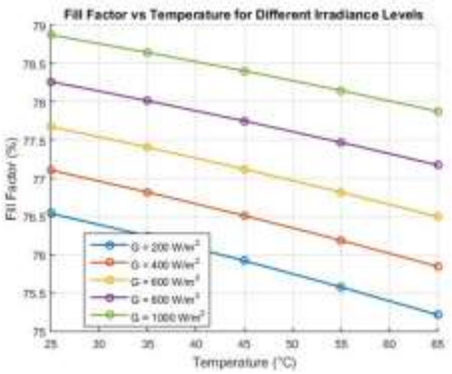
Figure 6. Maximum power curve with Solar cell temperature

5. Fill factor curve with solar cell temperature:

The results presented in Figure (7) illustrate the relationship between the Fill Factor (FF) and temperature at different solar irradiance levels ranging from 200 W/m² to 1000 W/m². It is observed that FF decreases almost linearly with increasing temperature across all irradiance levels, indicating a decline in solar cell efficiency as temperature rises. At 25°C, FF increases with irradiance, reaching approximately 80.67% at 1000 W/m² and around 78.7% at 200 W/m² in Monocrystalline, while in polycrystalline; FF is slightly lower, measuring about 78.87% and 76.6%, respectively. Similarly, at 65°C, FF drops to approximately 79% at 1000 W/m² and 77.6% at 200 W/m² in monocrystalline, whereas in polycrystalline, it further declines to about 77.7% and 75.2%. These trends confirm that temperature significantly impacts FF, leading to a reduction in performance, while solar irradiance has a minor positive effect, slightly increasing FF as irradiance increases.



Monocrystaline PV module

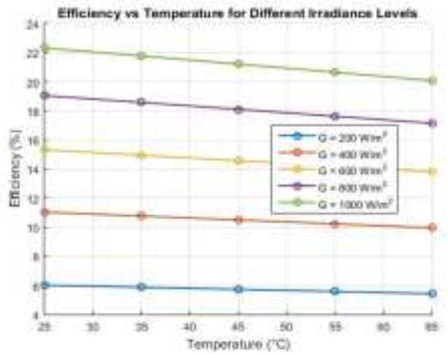


Polycrystaline PV module

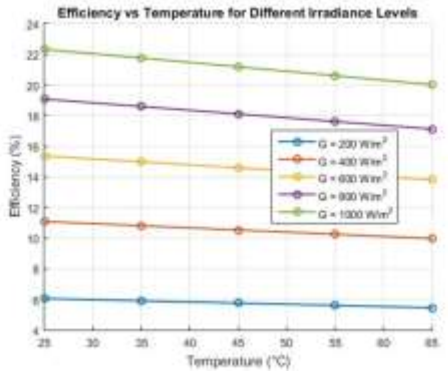
Figure 7. Fill factor curve with solar cell temperature.

6. Efficiency curve with solar cell temperature:

The results presented in Figure (8) illustrate the relationship between solar cell efficiency and temperature at different solar irradiance levels ranging from 200 W/m² to 1000 W/m². It is observed that efficiency decreases almost linearly with increasing temperature across all irradiance levels, indicating a decline in energy conversion efficiency as temperature rises. Additionally, efficiency significantly increases with higher irradiance. At 25°C, efficiency is approximately 6.4% at 200 W/m² and 22.4% at 1000 W/m² in monocrystaline, while in polycrystaline, it is slightly lower at 6% and the same 22.4%, respectively. At 65°C, efficiency drops to around 6% at 200 W/m² and 20.2% at 1000W/m² in monocrystaline, whereas in polycrystaline, it decreases to 5.8% and 20%, representing a decline of 10.71% and 9.81%, respectively. These findings confirm that solar cell efficiency is significantly influenced by both temperature and solar irradiance, where efficiency improves with increasing irradiance but deteriorates with rising temperature.



Monocrystaline PV module



Polycrystaline PV module

Figure 8. Efficiency curve with solar cell temperature.

This study is based solely on simulation results using MATLAB without direct validation through experimental or field data. While simulations provide valuable insights into performance trends and comparative analysis under controlled conditions, real-world environments involve additional variables such as shading, dust accumulation, and inverter performance.
Therefore, future work is recommended to involve experimental validation of the simulation results using field-tested PV modules in various climatic conditions. Such comparisons would enhance the accuracy of the conclusions and ensure the applicability of the findings for large-scale solar energy implementations in real-world settings.

V. CONCLOUSION

This study examined the impact of temperature and solar radiation intensity on the efficiency of two types of photovoltaic (PV) cells: monocrystalline and polycrystalline, using MATLAB-based modeling and simulation. The results indicate that PV cell efficiency decreases with increasing temperature due to a significant reduction in open-circuit voltage (Voc), while the short-circuit current (Isc) experiences a slight increase. On the other hand, higher solar radiation levels enhance PV cell efficiency and power output, with a more pronounced effect on current rather than voltage.

The findings suggest that monocrystalline PV cells exhibit superior performance in high-temperature environments compared to polycrystalline cells, as they demonstrate a lower efficiency drop with rising temperatures. However, polycrystalline PV cells may still be a cost-effective option in regions where temperature variations are minimal, offering a balance between affordability and performance.

Based on these findings, future research should focus on enhancing PV efficiency through strategies such as cooling systems, advanced materials, and intelligent solar tracking mechanisms, which can contribute to maximizing renewable energy generation while minimizing thermal losses in PV systems.

VI. REFERENCES

1. M. Sim and D. Suh, "A heuristic solution and multi-objective optimization model for life-cycle cost analysis of solar PV/GSHP system: A case study of campus residential building in Korea," Sustainable Energy Technology and Assessments, vol. 47, p. 101490, 2021. doi: 10.1016/j.seta.2021.101490.
2. S. Eshtaiwi, M. Aburwais, M. Elayeb, M. Abozaea and M. Shetwan, "Rooftop PV systems as a solution to the electrical power shortage in Libya," 13th Mediterranean Conference on Power Generation, Transmission, Distribution and Energy Conversion (MEDPOWER 2022), Hybrid Conference, Valletta, Malta, 2022, pp. 441-447, doi: 10.1049/icp.2023.0033.
3. M. Fterich, H. Chouikhi, S. Sandoval-Torres, et al., "Numerical simulation and experimental characterization of the heat transfer in a PV/T air collector prototype," Case Studies in Thermal Engineering, vol. 27, p. 101209, 2021. doi: 10.1016/j.csite.2021.101209.
4. B. R. Paudyal and A. G. Imenes, "Investigation of temperature coefficients of PV modules through field measured data," Solar Energy, vol. 224, pp. 425-439, 2021. doi: 10.1016/j.solener.2021.06.013.
5. J. Adeeb, A. Farhan, and A. Al-Salaymeh, "Temperature effect on performance of different solar cell technologies," Journal of Ecological Engineering, vol. 20, no. 5, May 2019.
6. D. Dhass, E. Natarajan, and P. Lakshmi, "An investigation of temperature effects on solar photovoltaic cells and modules," International Journal of Engineering, Transactions B: Applications, vol. 27, no. 11, Nov. 2014.
7. W. Al-Shohani, "Numerical and experimental investigation for analyzing the temperature influence on the performance of photovoltaic module," AIMS Energy, Sept. 2022.
8. M. I. Yusoff, L. W. Zhe, M. Irwanto, and S. Ibrahim, "Investigation of the effect of temperature on photovoltaic (PV) panel output performance," International Journal on Advanced Science, Engineering and Information Technology, Oct. 2016.
9. S. Alsadi and T. Khatib, “The effect of temperature on photovoltaic module efficiency: Development of an improved coefficient-based model,” Sustain. Energy Technol. Assess., vol. 47, p. 101409, 2021.
10. The University of Toledo, Department of Physics and Astronomy, "Fundamental properties of solar cells," SSARE, PVIC, Jan. 31, 2012.

Almotaz Bellah Abouda, a faculty member at the Faculty of Industrial Technology, Department of Electromechanical Engineering.
Head of Studies and Consultations Department at the College’s Research and Consultations Center former Deputy Director of the Center for Renewable Energies in the period 2022-2023.
collaborating with the Electricity Company during the years 2019-2022.